DOCUMENT RESUME

ED 156 524 SE 024 561

AUTHOR Blecha, Milo K.; Horak, Willis J.
TITLE A Science Curriculum for Pre-Service Elementary Teachers.
PUB DATE Apr 78
NOTE 13p.; Paper presented at the annual meeting of the National Science Teachers Association (Washington, D.C., April 1978); For related document, see SE 024 560

EDRS PRICE MF-$0.83 HC-$1.67 Plus Postage.
DESCRIPTORS *College Science; Curriculum; Elementary Education; Elementary School Science; *Elementary School Teachers; Higher Education; *Preservice Education; Program Descriptions; Science Education; *Teacher Education

ABSTRACT

In this paper, the science program for preservice elementary school teachers at the University of Arizona, Tucson, is described. The philosophic rationale behind the program and descriptions of one-semester, three-unit courses in the Departments of Mathematics, Physics, Chemistry, Geology, Astronomy, and Biology are provided. (CP)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

A SCIENCE CURRICULUM FOR PRE-SERVICE ELEMENTARY TEACHERS

U S DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

Willis Horak

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC) AND USERS OF THE ERIC SYSTEM."

Milo K. Blecha

Willis J. Horak

Paper presented at the Annual Meeting of the National Science Teachers Association, April 9, 1978 in Washington D.C.

SE 024 561

A SCIENCE CURRICULUM FOR PRE-SERVICE ELEMENTARY TEACHERS

For many years the University of Arizona has been concerned with the quality of science education in the elementary schools. It has long been the practice of the College of Education to require as a condition of admission into the Elementary Education Program a course, or series of courses, in science. At the University of Arizona, however, the science requirement has been structured to deal exclusively with the problems of the pre-teacher. This program of courses, known locally as the Science-12 series, is the existing framework within which the present liberal arts requirements are conceived, and a brief description of these courses and how they relate to the Elementary Education Program follows.

Prior to 1963, the science courses taken by pre-teachers were those general introductory courses available to all students in the Liberal Arts College. The College of Education admits students in the junior year; the first two years of the student's education are provided by the College of Liberal Arts. The previous science requirements were of the same nature as the general Liberal Arts requirements, which is predicated on the view that exposure in some depth to any laboratory science is an adequate introduction to science as a liberal art. While this may be a defensible position from the standpoint of cultural awareness, it did not serve the elementary pre-teacher well. What they needed far more than depth was a breadth of

experience in the sciences, so that they could take resource material in a variety of fields and confidently prepare a general science unit from it. They did not need a sophisticated understanding of specific concepts in physics, for example, but rather a general view of how physics looked at problems, what sort of problems it looked at, and how these problems and the manner of their solution related to problems, say, in biology. They of course needed to come out with some knowledge of the physical world, the biological world, and the chemical world. But also, they needed a good notion of what can be called the Scientific Method - plus an idea of the perspective from which science views the world, what problems it likes to attack, and what common properties the various branches of science share.

The courses then required were laboratory courses. As such, they ostensibly gave the student experience in meeting nature head-on and in drawing general conclusions from the experiments performed in the lab. Too often, though, the laboratory was not given the direct attention of the senior man in the course, and too often it degenerated into a cookbook exercise, in which no particular goal was reached.

In short, the courses were not serving the needs of the clientele. It was strongly felt that what was necessary was to switch emphasis in the requirements made on the pre-education students, so that the courses would speak more directly to their needs. "Their needs" were generally agreed to conform closely with the then-developing AAAS requirements, although the decision to proceed was made more or less independently of this development. To treat the subjects in this fashion required a whole new series of courses. To this end, at the request of the department of elementary education, one-semester three-unit courses were introduced by the department of Mathematics, Physics, Chemistry, Geology, Astronomy, and Biology, each specifically designed

for elementary education students. This choice was made over the alternative general science course for reasons of principle and administrative convenience which seemed, and still seems, overwhelming.

The five courses are all required for entrance into the Elementary Education Program. They form a loosely organized whole; the professors in charge including some from elementary education meet to decide overall policy, and coordinate the courses to some extent, but otherwise the courses have autonomous syllabi and organization. The material taught varies from year to year in each course, depending on the instructor. But the general view of what the course tries to accomplish is kept constant as far as possible.

The knowledge and attitudes which these courses try to promulgate is vital to the successful teaching of science. This knowledge is also useless unless the teacher has some notion about successful ways to teach it. Some of this is gained by example in the courses themselves. But most important to the future teacher is the course in science teaching methods in the Education College, which the students take in their junior year, and which is regarded as the final course in the science series. It is here that they begin to put into practice what they have presumably gained from the preparatory science courses, and where they learn to cope with the resource material available to them.

The Science 12 courses are presently constituted as an autonomous series of courses with more or less common clientele and a unifying philosophy. It is misleading to consider them as a series, since they are not taken serially (with the exception that physics and chemistry must precede astronomy, geology, and biology). Each of them, as a result, must approach its field at about the same level as any other. The enrollment figures show that, in fact, they are taken more or less at random, subject to this

restriction, since the only significant attrition takes place between the physics-chemistry and geology-biology pairs of courses.

Prerequisites for the courses are nil. Entrance requirements to the College of Liberal Arts specify one year of high school algebra. It is dangerous to assume from this that the students have any facility with mathematics. Although no thorough documentation exists, mathematics pre-tests given in physics and biology courses show that about half of the students have a reasonable working knowledge of algebra. A percent are taking calculus. At the other end of the spectrum, a few percent have negotiated admission with no math whatsoever beyond elementary school. The same sort of preparation is true for science. Liberal Arts requirements specify one high school unit of lab science, but there is not much unanimity in the science taken. Again, a significant minority have some considerable sophistication in science, but the majority is virtually innocent of previous exposure to this kind of thinking.

Given that most of the students have a minimal preparation, and given that one semester is all that is available to each subject, it is difficult to cover much factual material with any confidence that it will be retained. The general point of view adopted in these courses is that they provide enough tools so that factual material can be absorbed by the student later, when it becomes necessary to their teaching.

It is, of course, necessary to present some content. In order to illustrate the tools, you must do it with content; in order to talk about the structure of science, you must show the structure with content. But there is no way by which we can anticipate just those facts that the teacher will have to--or want to--teach ten years from now. Even five years ago, a teacher presenting a unit on planetary astronomy could take the treatment out of a book. This year's

teacher, and next year's, is going to be driven by the children into talking about satellites in earth-moon orbits, Mars and Venus probes, and the space shuttles; material like this is not in the book--the elementary book. But if they have had some experience with the basic notions of motion in this case, they can find the material in more "advanced" works, and bring it to the elementary level. So the tools we attempt to provide are: first, a skill in the techniques that science uses--classification, inductive and deductive logic, abstraction and analogy, geometrical construction; second, some basic knowledge of the principal ideas of the sciences; and third, some experience in the process of passing these on to the pupils.

In the following section, brief syllabi and/or descriptions of the present courses are given. It will be seen that the general process viewpoint is maintained, although the "tools" take several forms. Often the form is that of specific behaviors in the sense of the AAAS guidelines, and often those behaviors specifically treated in the AAAS guidelines are emphasized in the courses. The spirit of the guidelines permeates the course structure, even when it is only implicit.

Course Descriptions

Physics 12

It is highly unlikely that a significant fraction of the students will retain large quantities of factual information after leaving the course. The major intent, then, is to show how physics develops and how the major concepts are interrelated. We try to show the topics dealt with by phsicists and to give some indication of the intellectual processes involved. Since concrete examples are used in illustrations, factual material is also presented. It is our intent that enough terminology and method of approach be conveyed that

the student can read with understanding resource material at some future time and adapt it to his own classroom situation.

No firm syllabus is specified, since it is impossible to cover any significant fraction of the topics in physics. Each instructor chooses to present the material which he feels will most effectively achieve the goals outlined above. The choice of text is the major influence on topics covered. Those topics emphasized are those which seem to have the most current appeal, e.g. space flight.

The Physics 12 course is laboratory-oriented and designed around commercially available kits which have been developed for teaching physics in the elementary school classroom. Basically the course uses the materials available in the Elementary Science Study curriculum. This introduces preservice elementary education majors to one of the three N.S.F. sponsored science programs in the elementary school. Attendance is not required, however laboratory reports are checked and graded before students leave the laboratory. The reports are assigned either a satisfactory or unsatisfactory grade.

Along with the laboratory work, three exams on physics principles are given. The grades on these exams constitute approximately 60% of the final grade. The Physics 12 course is not self-paced and all students take the exams at the same time. Questions relate closely to the laboratory experiences and to exercises found at the end of each chapter.

The Physics 12 content includes such topics as optics and light, water flow, balancing, heating and cooling, electricity and magnetism, kitchen physics, and the pinhole camera.

Chemistry 12

The Chemistry 12 course presently is designed around five major criteria.

These are (1) a self-paced format, (2) an open laboratory, (3) a non-punitive grading system, (4) a one student to one teacher testing situation for most of the course, and (5) behaviorally-designed tests or competency measures.

The self-paced open-laboratory format is designed for students who work on different experiments at their own individual rate. The chemistry laboratories are open approximately forty hours a week, and students may elect to work any proportion of that time. The experiments are numbered, and the reagents necessary for each experiment are readily available. The choice of times to work makes some laboratory sections crowded and some laboratory sections nearly empty.

The non-punitive grading system allows all students to successfully pass the course. Only A, B, C, and incompletes are offered. The final course grade depends upon the number and quality of units completed. The competency measure is used to assess the quality of the completed work. This procedure has led to some problems in enrollment with students putting off work until the end of the term and then receiving "Incomplete" for their final grade. The competency measures are behaviorally oriented. While many of the experiments are cookbook, the competency measure requires many explanations, graphing, and interpretation of data.

The content of the Chemistry 12 course includes such topics as observation and inferences, measurement, formulas and chemical reactions, properties of matter, energy, heat, and temperature, solutions, atomic structure, chemical reaction rates, and introduction to organic chemistry.

Biology 12

Biology 12 is a one-semester, three-unit course designed especially for majors in elementary education. It is scheduled for two lectures and one laboratory period per week for the semester. Similar courses in physics

and chemistry are prerequisites. Enrollment is approximately 150 students each semester.

Based on experiments during the past three years, Biology 12 is now designed along behavioral lines similar to SAPA materials, and all instruction is individualized. The course consists of 74 behavioral objectives which have been sequenced into a behavioral hierarchy and further grouped into 21 instructional units. The flow of objectives is arranged such that each objective logically follows and builds upon those objectives preceding it. The lower part of the hierarchy provides the basic tools or competencies which the student will need to accomplish the upper objectives. The upper objectives emphasize biology from the standpoint of what many biologists actually do--make and test inferences, collect and handle data, and communicate their results and conclusions to others.

All of the course objectives are stated in terms of observable student performance, and designed so the student will know exactly what is expected of him. From this standpoint, the student can more effectively study a unit, and the instructor can more readily ascertain whether or not the student is competent. A competency measure does not involve rote feedback from a student. The materials used for the competencies are never the same as that in the instructional units, so that the student must apply his learned behavior to a somewhat different but analagous situation.

If a student performs unacceptably on a competency measure, he may retake a similar, but not identical measure at a later time without penalty. In this way, each student proceeds at his own rate, instruction is individualized, and assessment is immediate.

During the first week of instruction, each student is given a diagnostic measure (called a pre-measure) of his science competencies as described by

the lower half of the hierarchy. If a student demonstrates competency in a specific unit of instruction, he is given immediate credit, and he is not required to do that unit of instruction. Some students do quite well on the pre-measure and begin the course at a higher level on the hierarchy than other students.

At the present time, the instructional material is provided for the student. Included in this material is a rationale, explanation of the particular topic or concept, and several activities which emphasize the unit. These activities may be performed by the student at home or in the laboratory. The content includes such topics as the microscope, the cell, energy, ecology, evolution, and populations.

A post-measure of science competencies is administered at the end of the course to check for retention of behaviors acquired throughout the course. Data obtained throughout the semester are used to test the validity of the behavioral hierarchy to correlate student success and rate of achievement with student attitudes, and to revise the instructional units and competency measures. The close student-instructor contact during the instruction and competency measures provides the instructor with an invaluable source of information (feedback) on the success of the instructional units.

Finally, the semester grade is based on the completion of a certain number of instructional units. In order for the student to be awarded the highest course grade, he must show competence in all 74 objectives.

Astronomy 3

The Astronomy 3 course is the science course which most strongly resembles regular University-type laboratory science classes. In fact, it is included in the elementary education science sequence as an option and was not initially developed when the other Science 12 courses were first introduced. Astronomy 3

is basically a lecture-laboratory course. Students attend three hours of lecture a week. The laboratory experience is scheduled during the same three hours. Extensive use is made of the Grace Flandrau Planetarium on the University of Arizona campus. As a follow-up to this course, students may elect to serve as guides for elementary school field trips through the planetarium. Elementary children are scheduled for field trips every morning between the hours of 9:00 and 12:00, and pre-service teachers may guide for two to five hours a week during that time. In this way, they are introduced to methods presently used to relate astronomy concepts to children.

Course content for Astronomy 3 includes such concepts as the universe, radiation, earth, sun, stars, astronomical instruments, and galaxies.

Geology 12

Geology 12 is usually taken as the last course in the science 12 sequence. Much of the work in this course is field based. Students are scheduled for field trips that give them the practical application of earth sciences as well as a theoretical basis from which to function. Emphasis is placed on developing unit materials, demonstrations, projects and experiments. Course content includes the study of: rocks, minerals , metamorphism, earthquakes, structural geology, mountain building, weathering, water, glaciers, sedimentation, stratigraphy, paleontology and mapping the earths crust.

The course content is not developed along traditional lines. Behavioral objectives are not stated and the course content is sequenced around the processes of science which are patterned similiar to SAPA materials.

In a recent evaluation of the science 12 concept, it was proposed that no major changes be made in the general style of the courses. The autonomy which the present courses hold is one of their strengths, giving chemistry

from a chemists' point of view, physics from the physicists' point of view, etc.

Although not perfect by any means, the Science 12 program at the University of Arizona, has, without question, given pre-service elementary teachers a much broader depth and breadth needed in understanding the nature of science, which in turn should make for better teachers.